



SURVIVABILITY ENHANCED RUN-FLAT VARIABLE FOOTPRINT TIRES

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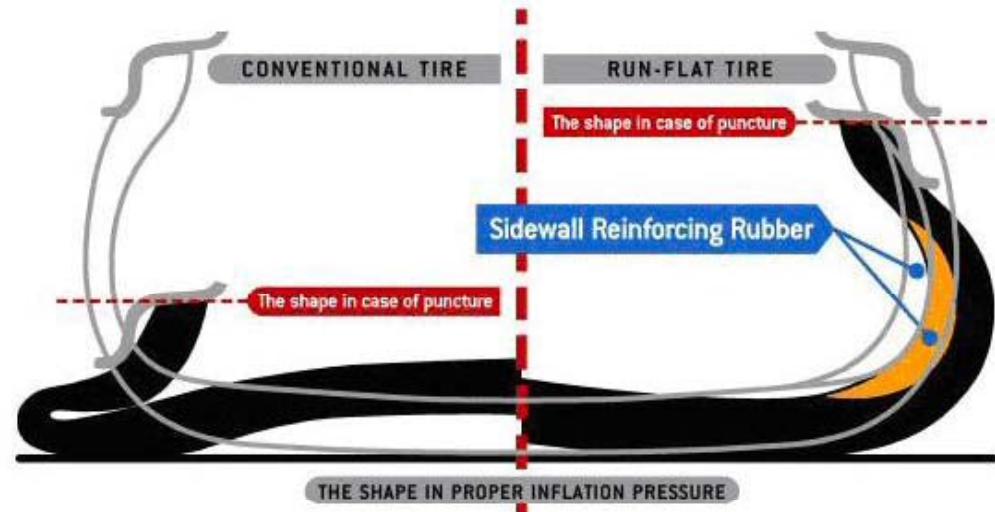
Current Run-Flat Technology

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MODELING AND SIMULATION, TESTING AND VALIDATION



Military Run-flat Tire with Insert [1]



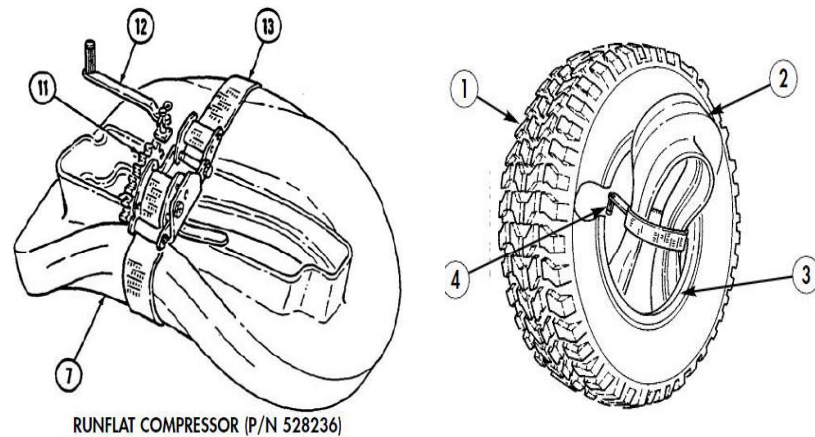
Comparison of Conventional Tire to a Stiff Sidewall Tire [2]

Current Run-Flat Technology Issues

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- WEIGHT
- LOGISTICS BURDEN
- SHOCK & VIBRATION
- SIZE LIMITATION
- PERFORMANCE

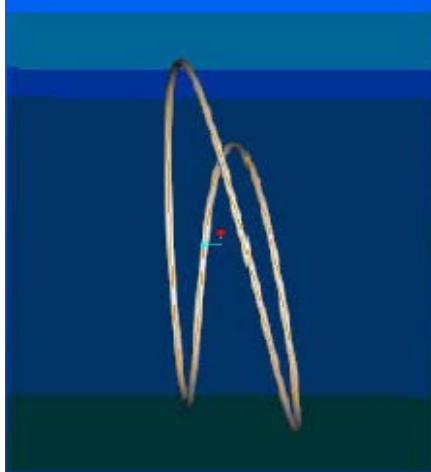


HMMWV Run-flat Insert Special Tool and Installation [2]

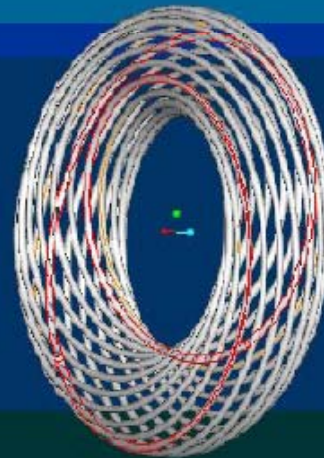
Spiral Spring Modeling

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Side view of
single wire of
tire spring

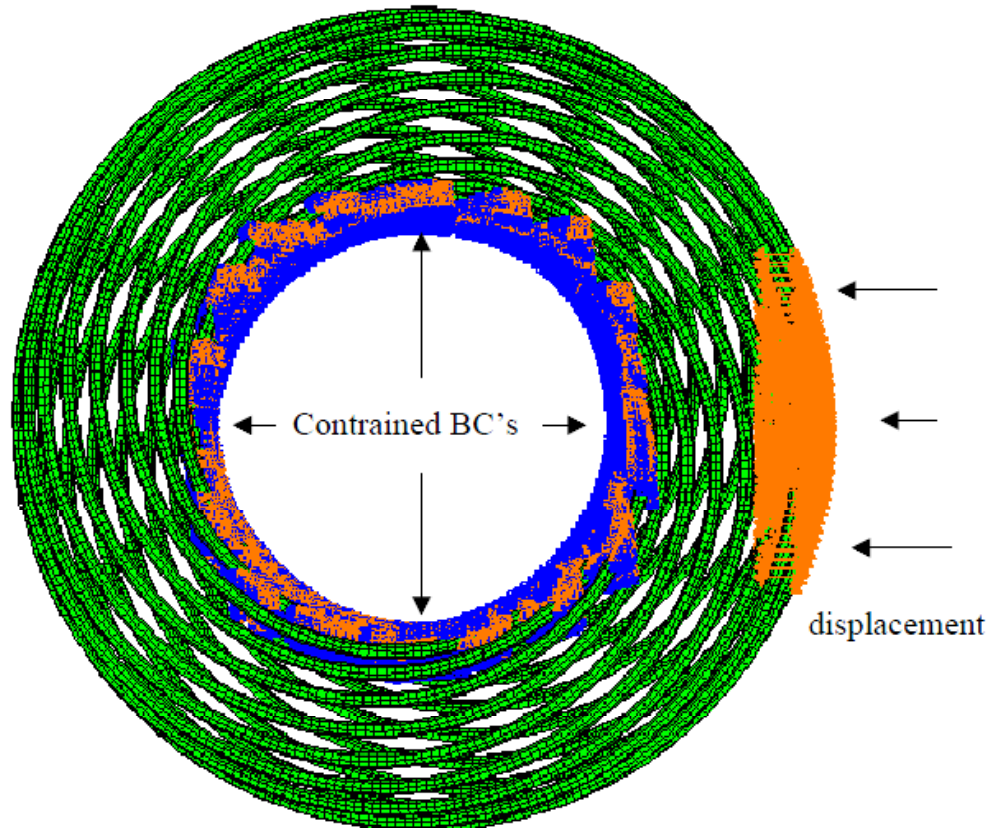


Isometric view of
the 10 circular
closed springs

Spiral Spring FEA

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Load and Boundary Conditions Applied on the Model for a First Order Foot Print Analysis

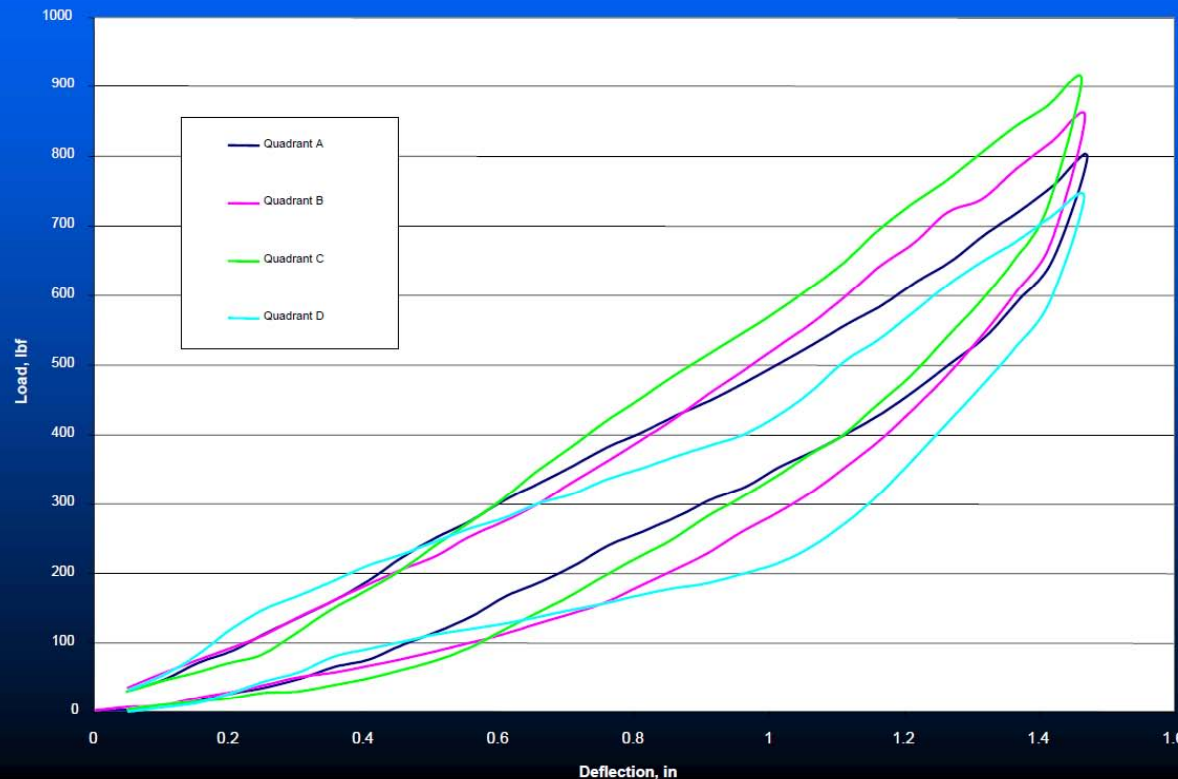
Load Deflection Testing

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Concept #2: Load- Deflection Testing on Prototype Run Flat Tire with Spiral Spring with 0 Psi inflation pressure (185/80R13 Passenger Tire).

Load Deflection @ Four Positions, Wire Only, No Air



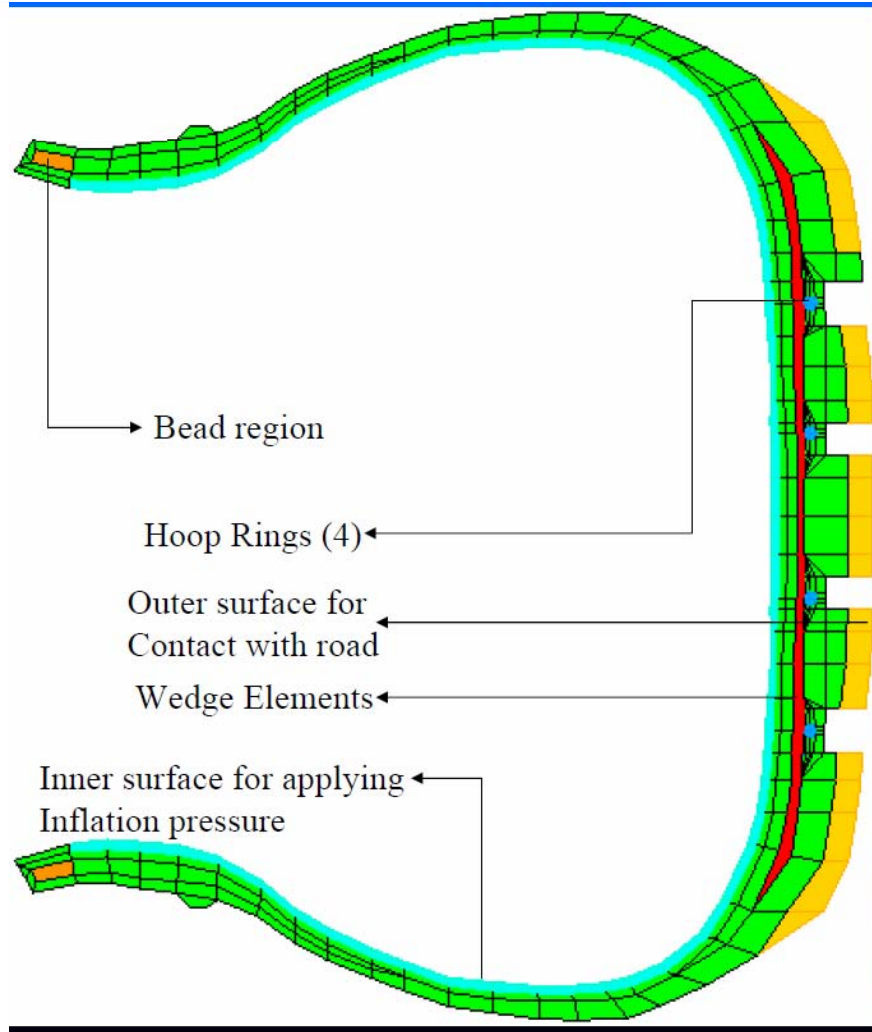
Carbon Fiber Reinforced Tire

- Composite Ring-Reinforced tire
- Comprising of carbon, which is encapsulated as composite hoops into the tire tread
- The undertread layer adheres the tire tread to the primed encapsulated composite hoops. Composite hoops will be spaced above belts in the undertread region.
- Carbon fiber is utilized with the binder so that the resulting composite has high modulus and high strength.

Carbon Fiber Hoop Tire Cross Section

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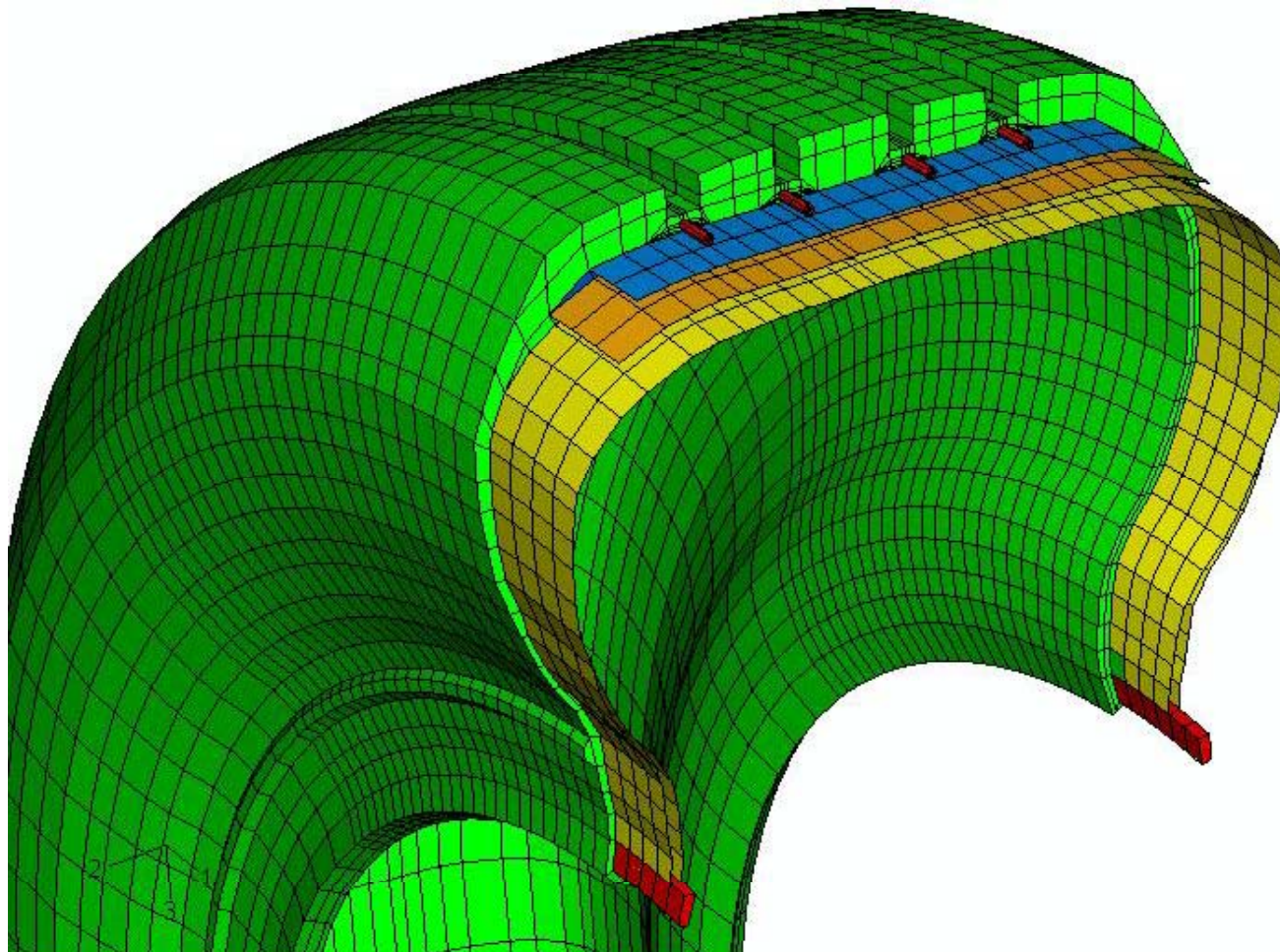
MODELING AND SIMULATION, TESTING AND VALIDATION



Survivability Enhanced Run-Flat Variable Footprint Tire Sectional View

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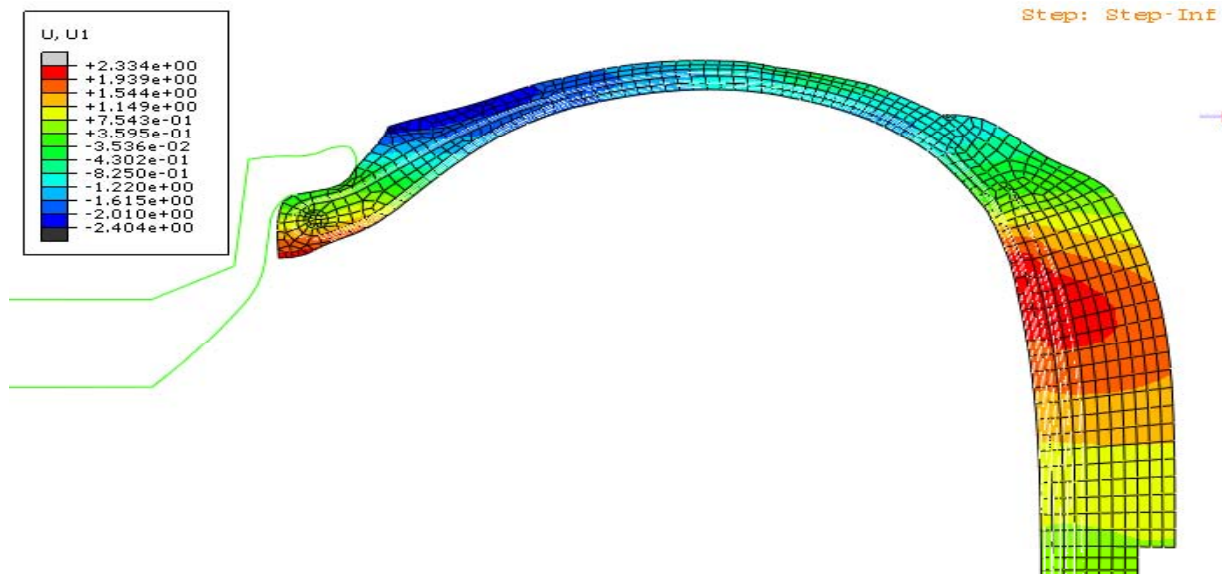
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FEA of Inflated Tire

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Carbon Fiber Hoop Tire

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Carbon Fiber Manufacturing



Testing

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Load Deflection



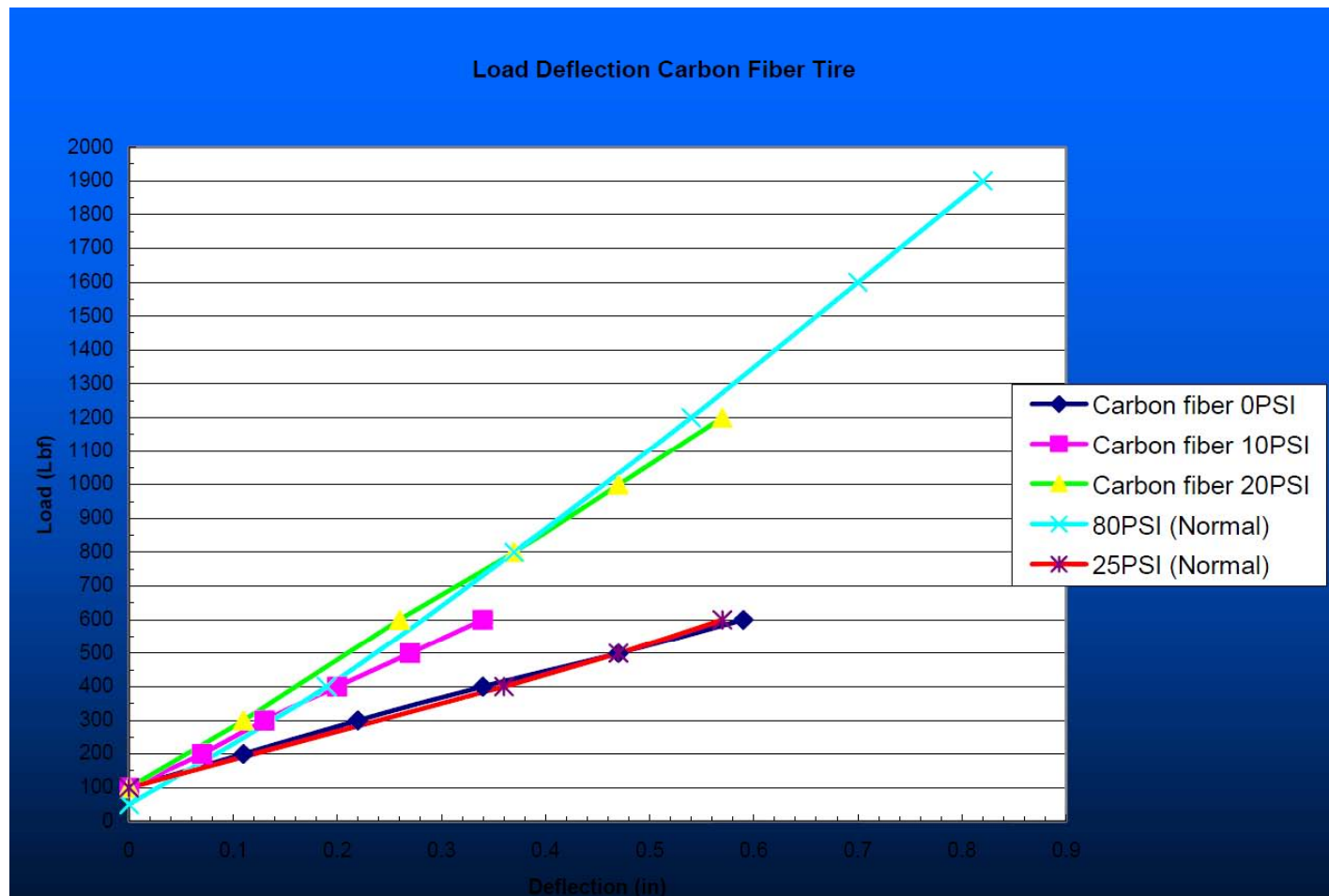
DURABILITY



Test Results

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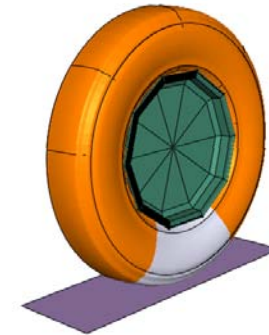
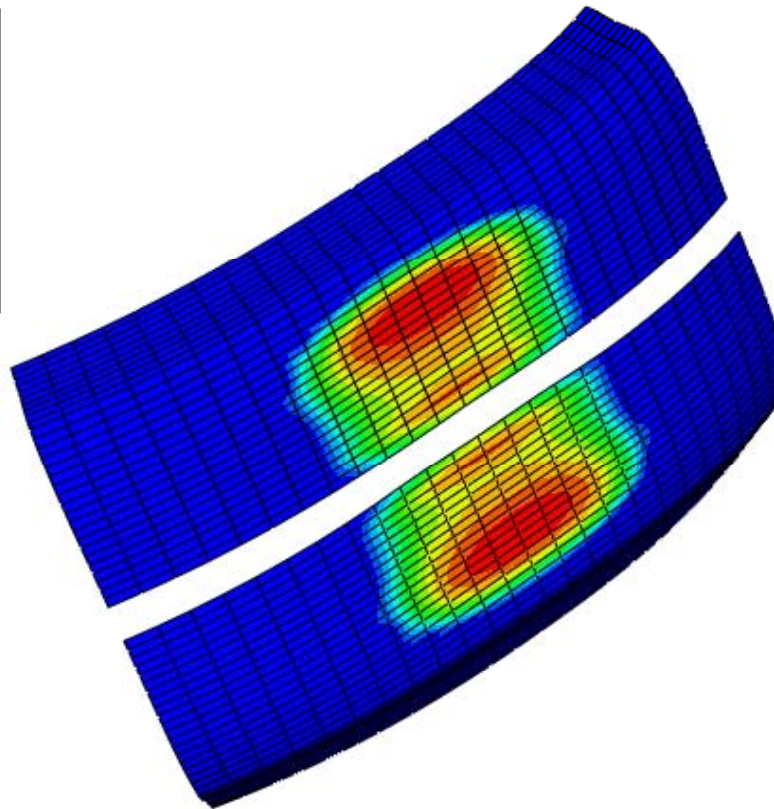
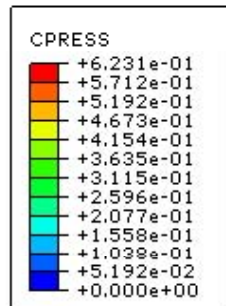
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Ground Pressure FEA

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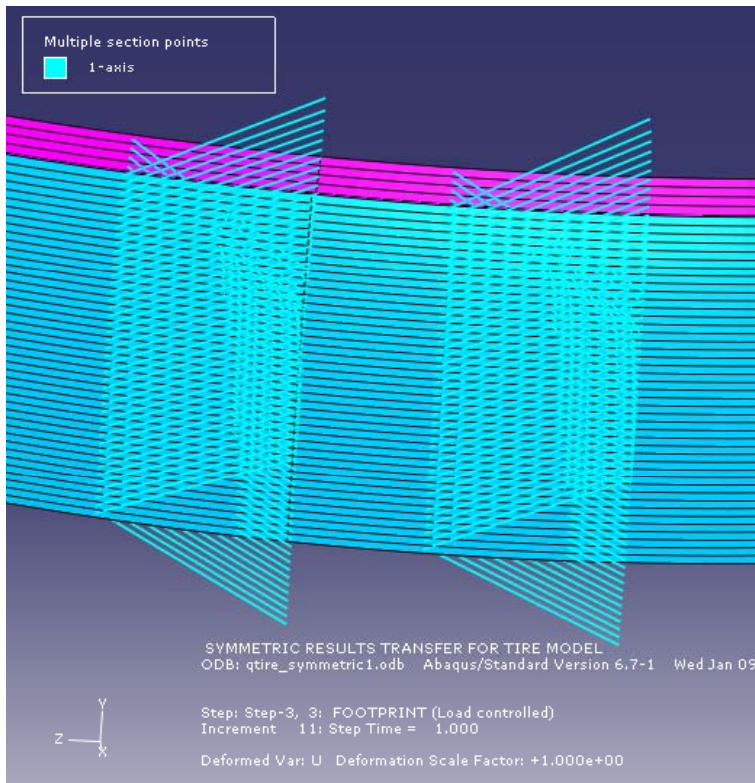
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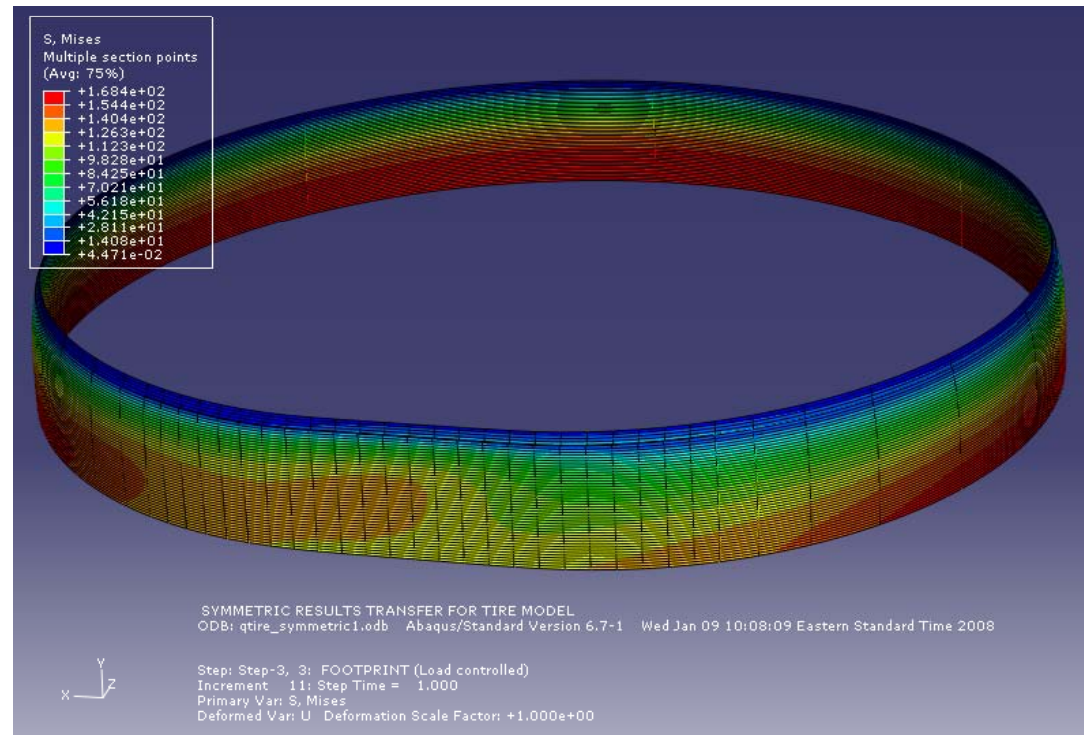
Stress in Carbon Fiber Hoop

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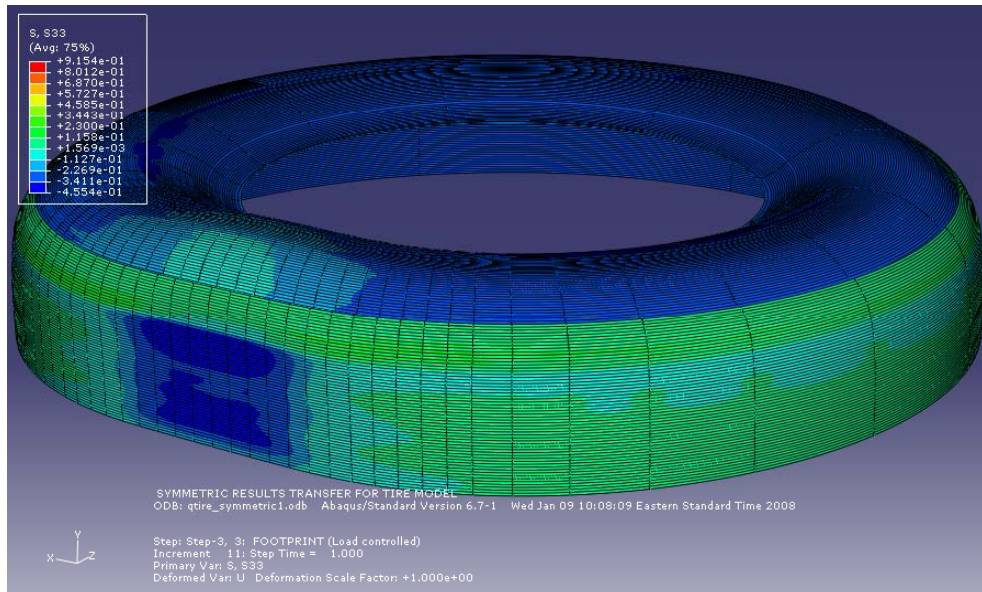
Steel Belt Orientations



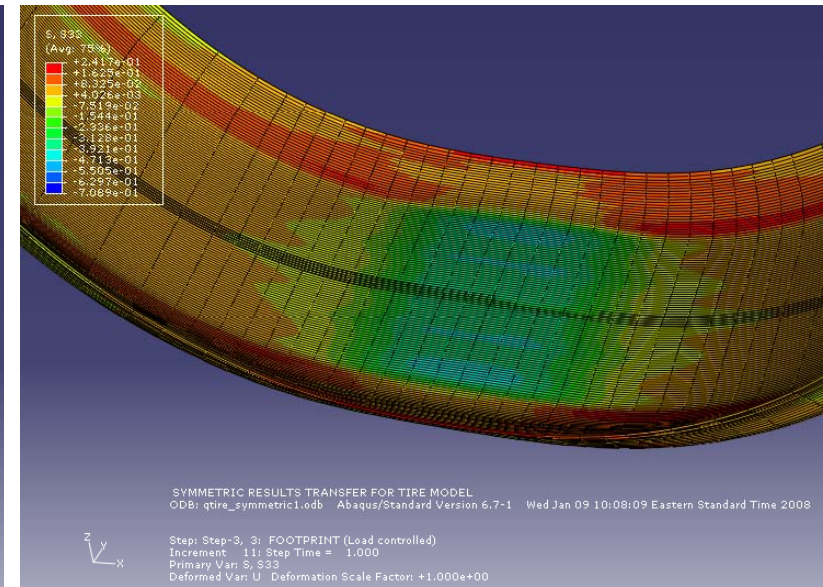
Mises Stress generated in carbon fiber
Max – 168.4 MPa

Core – Tread Interface Stresses

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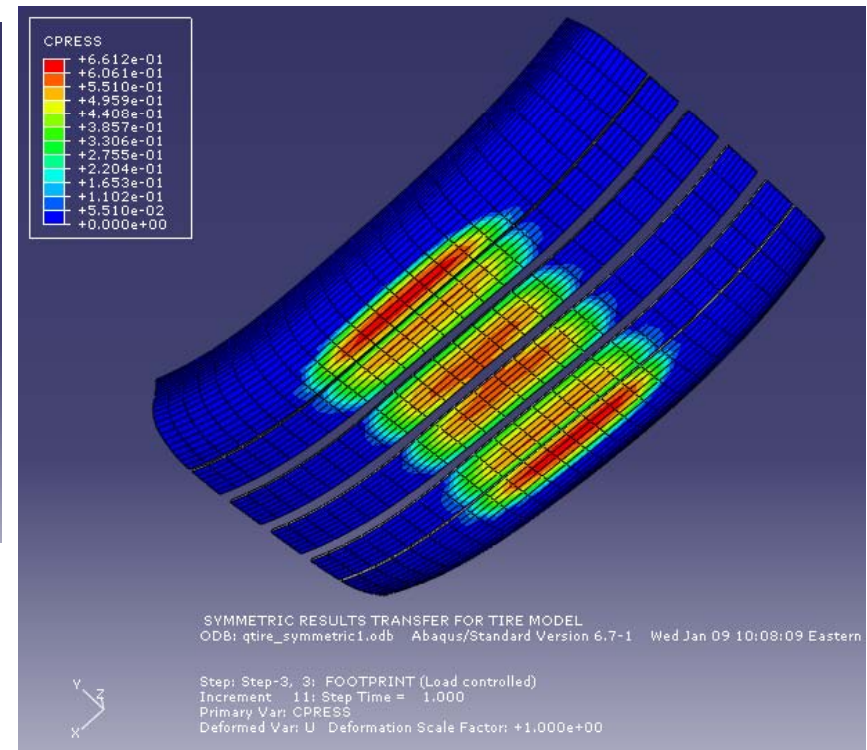
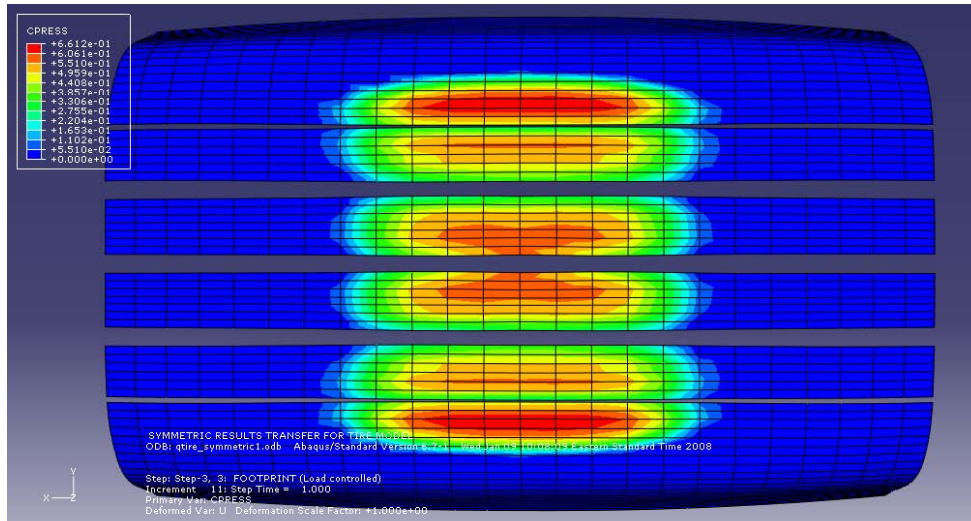
Maximum Normal Stress(S33) in the
Core Side = 0.9154 MPa



Maximum Normal Stress (S33) in the
Tread Side = 0.2417 MPa

Foot Print Area – Smooth Tire

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Contact Area (CAREA) = 21.08934 sq inch for half-tire

Total Contact Area = 42.17868 sq inch

Total Foot Print Area (Contact Area + Void Area) = 7.395251 in x 6.571889 in
= 48.600780 sq inch

Maximum Contact Pressure = 0.6612 MPa = 95.89 psi

Average Contact Pressure = $2335 / 42.17868 = 55.35$ psi



Benefits

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- **SURVIVABILITY**
- **RUN-FLAT RANGE GREATER THAN MISSION RANGE**
- **POTENTIALLY NO DEGREDDATION IN PERFORMANCE AT ZERO AIR PRESSURE**
- **UNSPRUNG MASS REDUCTION (*ELIMINATE RUN-FLAT*)**
- **REDUCED LOGISTICS BURDEN**
- **SAFETY (*ZERO OR SIGNIFICANTLY REDUCED AIR PRESSURE*)**
- **PERFORMANCE**
- **POTENTIAL TO BE USED ON VEHICLES THAT DON'T CURRENTLY HAVE RUN-FLATS**

Survivability Enhanced Run-Flat Variable Footprint Tires

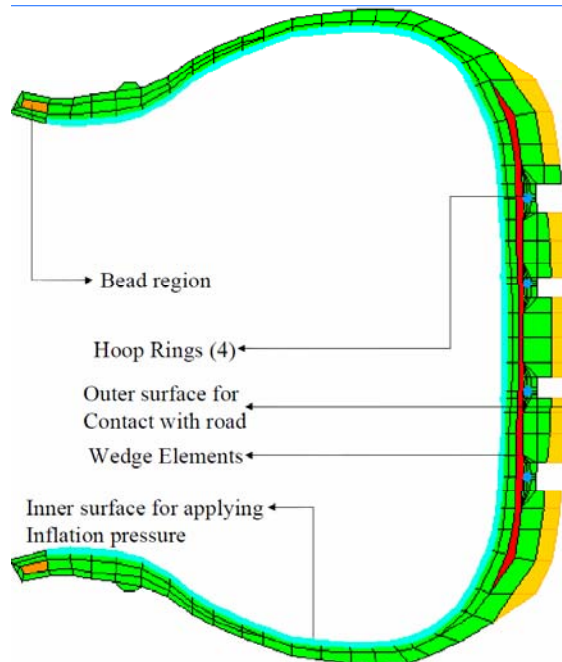
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TARDEC

DEVELOPING TOMORROWS TECHNOLOGY TODAY





Contacts/References

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15 July 2010.